6.0 ELECTRICAL TRANSMISSION

Section 6 discusses the transmission interconnection between the proposed Pico Power Project (PPP) and the existing electrical grid and the anticipated impacts that operation of the facility will have on the flow of electrical power in this region of California. To better understand the impacts of the proposed project on the regional transmission system and power flows, the analysis presented in this section focuses on the following issues: 1) the existing electrical transmission system in the immediate area of the PPP; 2) the proposed electrical interconnection between the PPP and the electrical grid; and 3) the impacts of the electrical interconnection on the existing transmission grid. Additional discussions focus on potential nuisances (electrical, magnetic, audible noise, and corona effects), safety of the interconnection, and a description of applicable laws, ordinances, regulations, and standards (LORS).

6.1 TRANSMISSION INTERCONNECTION ENGINEERING

Preliminary engineering of the proposed transmission interconnection was completed based on the results of the interconnection feasibility studies performed. This section summarizes information on the existing transmission facilities in the vicinity of the PPP project and other associated electrical facilities, as well as the proposed transmission interconnection. Please refer to the system impacts studies in Appendix 6 for additional information.

6.1.1 Existing Electrical Transmission Facilities

The site for the proposed PPP was selected, in part, for its proximity to the anticipated load and to the Silicon Valley Power (SVP) Kifer Receiving Station and nearby Scott Receiving Station. Figure 2.2-1 shows the proposed location of the PPP in relationship to the Kifer Receiving Station and Scott Receiving Station.

The existing transmission system will deliver the power generated at the PPP to the SVP electric grid. Figure 6.1-1 illustrates the existing 115 kV utility connections in the immediate area of the proposed PPP facility. The following transmission lines enter the Kifer Receiving Station and cross the proposed project site:

- Scott-Kifer 115 kV transmission line (SVP)
- Newark-Kifer 115 kV transmission line (PG&E)
- Kifer-San Jose B 115 kV transmission line (on same transmission structures as the Newark-Kifer 115 kV transmission line) (PG&E)
- Nortech-Kifer 115 kV transmission line (to be constructed prior to PPP construction) (PG&E)
- Kifer-NAJ 60 kV transmission line (SVP)

6.1.2 Proposed Transmission Interconnection System

The PPP, located adjacent to the Kifer Receiving Station, will not require a new transmission line. The new PPP on-site switchyard will connect directly to the Kifer and Scott Receiving Stations via the Scott-Kifer 115 kV transmission line that presently crosses the project site.

The proposed interconnection between the PPP and the Kifer and Scott Receiving Stations will consist of the following major facilities:

- A new 115 kV on-site switchyard at the PPP using a three-breaker configuration

- The new switchyard will intercept the existing Scott-Kifer 115 kV transmission line, and establish a new connection for this line to the PPP on-site switchyard.
- The portion of Kifer-San Jose B and Newark-Kifer 115 kV transmission lines that are currently on the PPP site will be placed underground between the northwest edge of the PPP site and the Kifer Receiving Station. This will involve moving the existing on-site lattice-type transmission tower from the center of the project site to the northwest corner of the project site on two steel monopole towers. Figure 6.1-2 is an profile view of the new connecting tower that will receive the existing lines at the point of underground connection.
- Modifications in the Kifer Receiving Station 115 kV bus to accept the underground Kifer-San Jose B and Newark-Kifer lines and the Kifer-Scott line.
- Relocation of the existing SVP 60 kV line, now located on the abandoned Pico Way.

The PPP will not require any new transmission corridors or any off-site transmission poles or other facilities. It will require one new on-site pole as a replacement for the existing lattice structure.

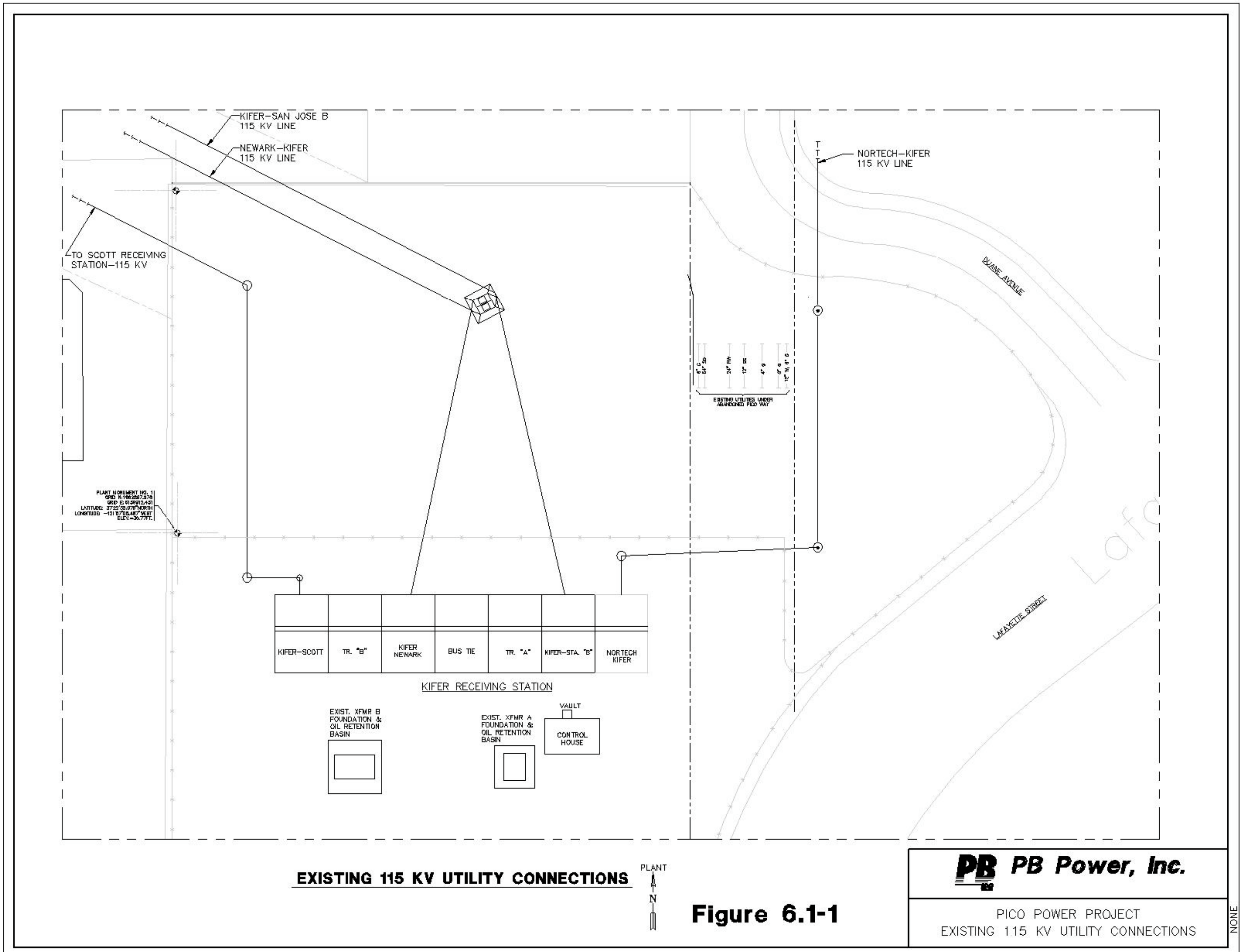
6.2 SYSTEM IMPACT STUDIES

Two system impact studies were completed for the PPP. One was prepared by PG&E to consider the potential effects of the PPP on the PG&E system. A second study was prepared by SVP to consider potential effects on SVP's system.

PG&E's System Impact Study is, presented in Appendix 6-B, and came to the following conclusions:

- The PPP does not have a significant impact on the PG&E transmission system. The only transmission system component that would load more heavily with the PPP in operation is SVP's 115 kV Scott-Kifer line. Because SVP plans to reconductor this line in late 2002, no PPP impacts to the transmission system are expected.
- The PPP will have the system benefit of relieving loading on PG&E's 115 kV transmission system in north San Jose. Presently, SVP imports more than 300 MW over this system to meet its peak summer load of over 400 MW. With the PPP generating up to 155 MW during the peak load period, SVP will import less power, and this will relieve potential overloading.
- During off-peak periods, the availability of the PPP also means SVP would import less power, relieving transmission system loads.
- The PPP does not introduce voltage problems to PG&E's system.
- The PPP does not introduce dynamic stability problems to PG&E's system.

SVP's System Impact Study was prepared by Navigant Consulting, Inc (see Appendic 6-C). This study indicated that the PPP would lead to one adverse system impact, a 104% overload of the Scott-Kifer 115 kV line. This would occur under normal and single contingency conditions due solely to addition of the PPP. Under a condition in which the Los Esteros-Northern Receiving Station (NRS) 230 kV line (currently in development) were to be delayed, the Scott-Kifer 115 kV line would load to 117% of its normal rating under summer peak conditions with the PPP in-service. Also without the Los Esteros-NRS 230 kV line in service, this circuit would exceed its emergency rating for 25 other Category B outages, 5 N-2 outages, and 5 bus outages (at Newark 230 kV and 115 kV, Northern Receiving Station 115 kV, and Trimble 115 kV). The highest loading on the Scott-Kifer 115 kV circuit would be 130% for a Category 'B' outage and 164% for a Category 'C' outage. The Los Esteros-Northern Receiving Station line is in



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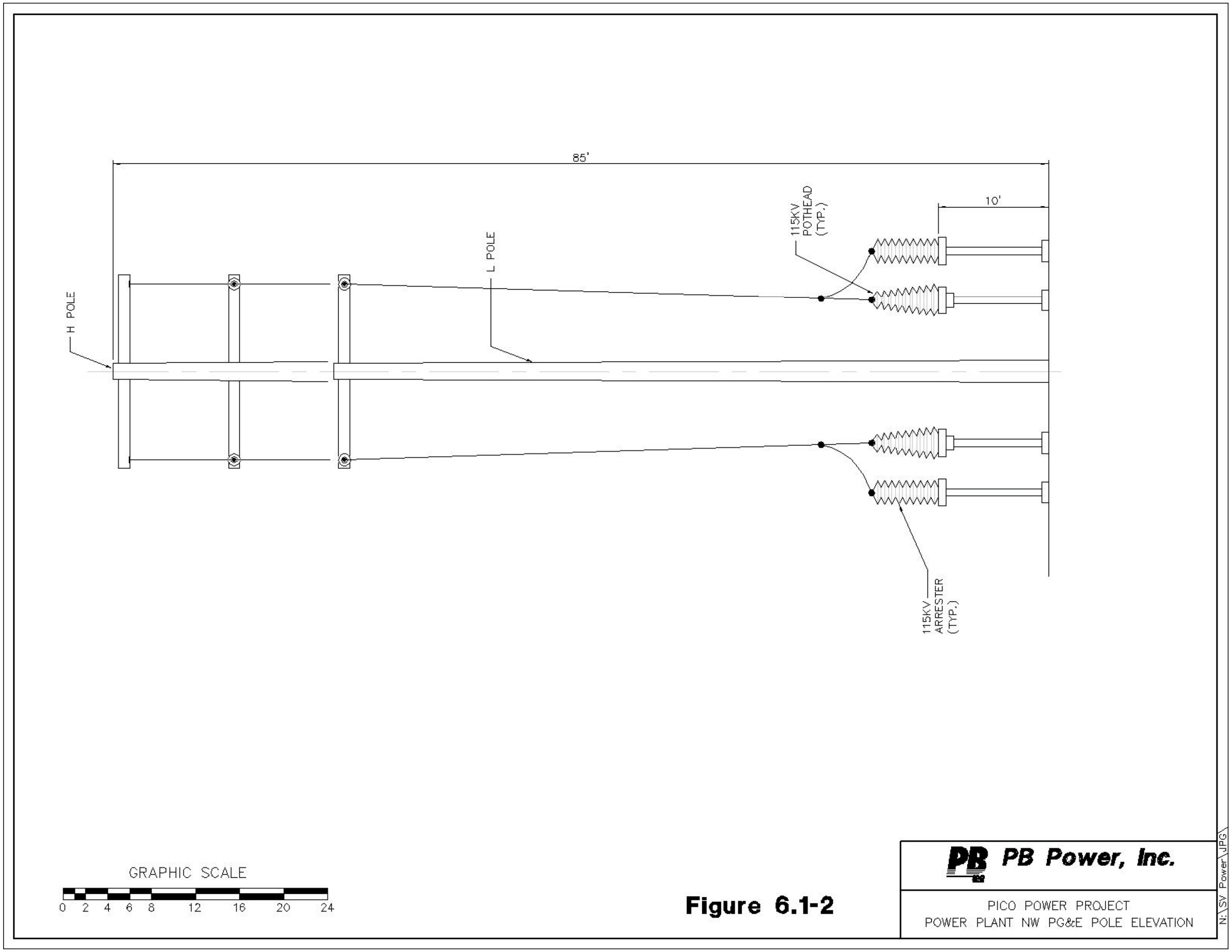
85'
10'
115KV
POTHEAD
(TYP.)
L POLE
H POLE
115KV
ARRESTER
(TYP.)
GRAPHIC SCALE
0 2 4 6 8 12 16 20 24
PB Power, Inc.
PICO POWER PROJECT
POWER PLANT NW PG&E POLE ELEVATION
N:\SV Power\JPG\

Figure 6.1-2

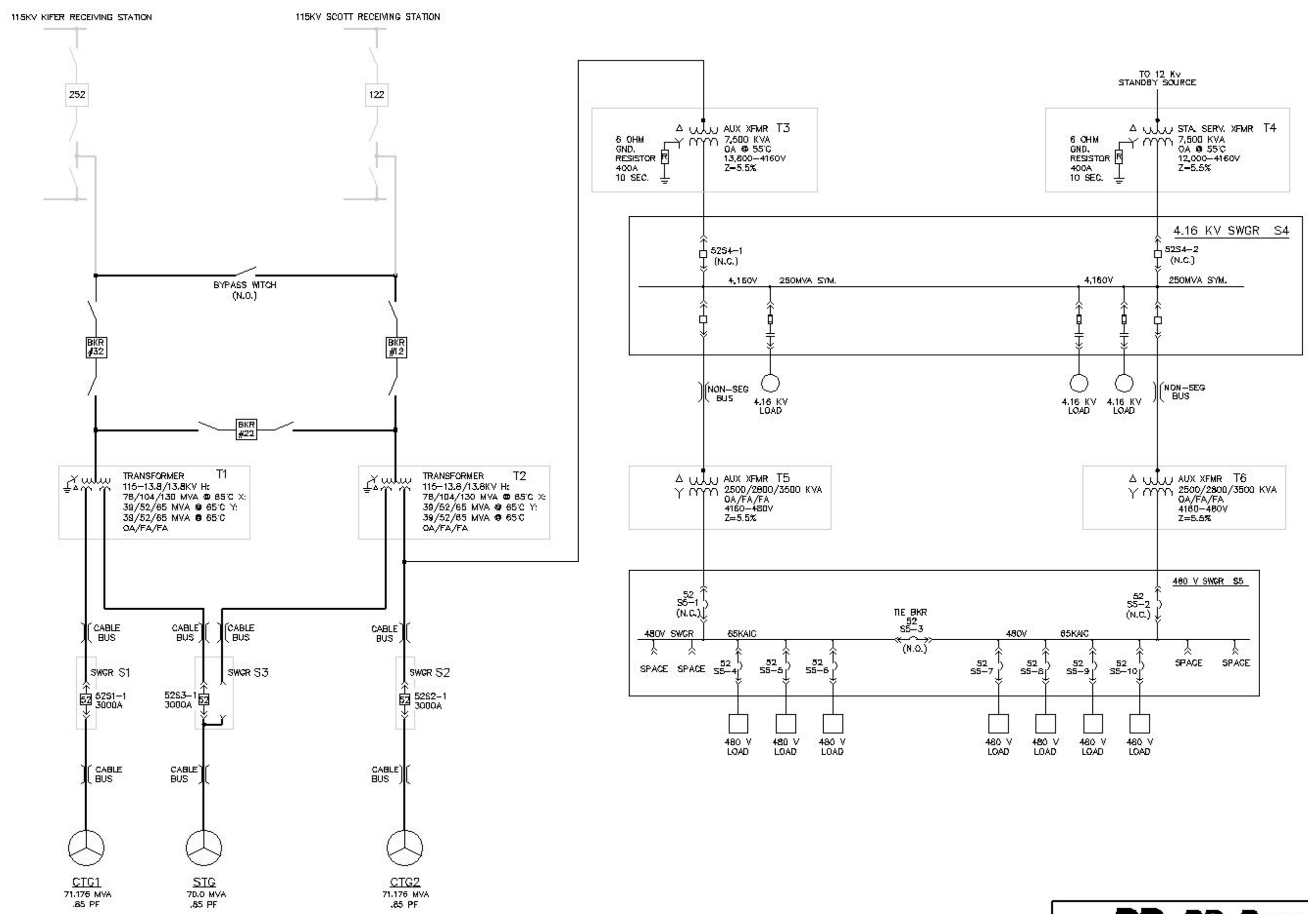

Figure 6.2-1

PB Power, Inc.

PICO POWER PROJECT
COMPOSITE ONE LINE DIAGRAM

currently in the environmental regulatory review phase and SVP expects to complete construction before December 2004, when the PPP is expected to come on line.

SVP is planning to reconductor the Scott-Kifer 115 kV line prior to the beginning of PPP operation. The reconductored line would utilize bundled 954 Al conductor (at present, it utilizes a single 954 Al conductor). This bundled conductor would have a normal rating of 1666 amperes and an emergency rating of 1908 amperes, which is twice the rating of the current line. These new ratings will be more that adequate to handle the loading levels identified in these studies even if the Los Esteros-Northern 230 kV line were to be delayed beyond the startup of the PPP.

The summer off-peak base case showed no loading violations under any of the Category 'B' scenarios studied. Two bus section outages caused overloads on some PG&E 115 kV lines, but the addition of the PPP did not increase these overloads.

6.3 TRANSMISSION LINE SAFETY AND NUISANCES

This section discusses safety and nuisance issues associated with the proposed electrical interconnection of the PPP. The PPP will not require any new transmission corridors or any off-site transmission poles or other facilities. The new PPP on-site switchyard will connect directly to the Kifer and Scott Receiving stations via the Scott-Kifer 115 kV transmission line that presently crosses the project site.

6.3.1 Electrical Clearances

Typical high-voltage overhead transmission lines are composed of bare conductors connected to supporting structures by means of porcelain, glass, or plastic insulators. The air surrounding the energized conductor acts as the insulating medium. Maintaining sufficient clearances, or air space, around the conductors to protect the public and utility workers is paramount to safe operation of the line. The safety clearance required around the conductors is determined by: normal operating voltages, conductor temperatures, short-term abnormal voltages, wind-blown swinging conductors, contamination of the insulators, clearances for workers, and clearances for public safety. Minimum clearances are specified in the National Electric Safety Code (NESC). Electric utilities, state regulators, and local ordinances may specify additional (more restrictive) clearances. Typically, clearances are specified for:

- Distance between the energized conductors themselves
- Distance between the energized conductors and the supporting structure
- Distance between the energized conductors and other power or communication wires on the same supporting structure, or between other power or communication wires above or below the conductors
- Distance from the energized conductors to the ground and features such as roadways, railroads, driveways, parking lots, navigable waterways, airports, etc.
- Distance from the energized conductors to buildings and signs
- Distance from the energized conductors to other parallel power lines

The existing Scott-Kifer 115 kV transmission line was designed and constructed to meet all national, state, and local code clearance requirements and is consistent with General Order 95 (GO-95) of the California Public Utilities Commission and PG&E’s guidelines for electric and magnetic field (EMF) reduction. Operation of the PPP will not change the operating characteristics of the existing Scott-Kifer 115 kV transmission line; therefore no impacts are expected.

6.3.2 Electrical Effects

The electrical effects of high-voltage transmission lines fall into two broad categories: corona effects and field effects. Corona is the ionization of the air that occurs at the surface of the energized conductor and suspension hardware due to very high electric field strength at the surface of the metal during certain conditions. Corona may result in radio and television reception interference, audible noise, light, and production of ozone. Field effects are the voltages and currents that may be induced in nearby conducting objects. A transmission line's 60 hertz (Hz) electric and magnetic fields cause these effects.

6.3.2.1 Electric and Magnetic Fields

Operating power lines, like the energized components of electrical motors, home wiring, lighting, and all other electrical appliances, produce electric and magnetic fields, commonly referred to as EMF. The EMF produced by the alternating current electrical power system in the United States has a frequency of 60 Hz, meaning that the intensity and orientation of the field changes 60 times per second.

Electric fields around transmission lines are produced by electrical charges on the energized conductor. Electric field strength is directly proportional to the line's voltage; that is, increased voltage produces a stronger electric field. The electric field is inversely proportional to the distance from the conductors, so that the electric field strength declines as the distance from the conductor increases. The strength of the electric field is measured in units of kilovolts per meter (kV/m). The electric field around a transmission line remains steady and is not affected by the common daily and seasonal fluctuations in usage of electricity by customers.

Magnetic fields around transmission lines are produced by the level of current flow, measured in terms of amperes, through the conductors. The magnetic field strength is also directly proportional to the current; that is, increased amperes produce a stronger magnetic field. The magnetic field is inversely proportional to the distance from the conductors. Thus, like the electric field, the magnetic field strength declines as the distance from the conductor increases. Magnetic fields are expressed in units of milligauss (mG). The amperes and, therefore the magnetic field around a transmission line, fluctuate daily and seasonally as the usage of electricity varies.

Considerable research has been conducted over the last 30 years on the possible biological effects and human health effects from EMF. This research has produced many studies that offer no uniform conclusions about whether long-term exposure to EMF is harmful or not. In the absence of conclusive or evocative evidence, some states, California in particular, have chosen not to specify maximum acceptable levels of EMF. Instead, these states mandate a program of prudent avoidance whereby EMF exposure to the public would be minimized by encouraging electric utilities to use low-cost techniques to reduce the levels of EMF.

Operation of the PPP will not change the operating characteristics of the existing Scott-Kifer 115 kV transmission line; therefore no EMF impacts are expected.

6.3.2.2 Audible Noise

Corona may result in the production of audible noise from a transmission line. Corona is a function of the voltage of the line, the diameter of the conductor, and the condition of the conductor and suspension hardware. The electric field gradient is the rate at which the electric field changes and is directly related to the line voltage.

The electric field gradient is greatest at the surface of the conductor. Large-diameter conductors have lower electric field gradients at the conductor surface and, hence, lower corona than smaller conductors, everything else being equal. Also, irregularities (such as nicks and scrapes on the conductor surface) or sharp edges on suspension hardware concentrate the electric field at these locations and, thus, increase corona at these spots. Similarly, contamination on the conductor surface, such as dust or insects, can cause irregularities that are a source for corona. Raindrops, snow, fog, and condensation are also sources of irregularities. Corona typically becomes a design concern for transmission lines having voltages of 345 kV and above.

Operation of the PPP will not change the operating characteristics of the existing Scott-Kifer 115 kV transmission line; therefore no audible noise impacts are expected.

6.3.2.3 Induced Current and Voltages

A conducting object such as a vehicle or person in an electric field will experience induced voltages and currents. The strength of the induced current will depend upon the electric field strength, the size and shape of the conducting object, and the object-to-ground resistance. When a conducting object is isolated from the ground and a grounded person touches the object, a perceptible current or shock may occur as the current flows to ground. The mitigation for hazardous and nuisance shocks is to ensure that metallic objects on or near the right-of-way are grounded and that sufficient clearances are provided at roadways and parking lots to keep electric fields at these locations sufficiently low to prevent vehicle short-circuit currents from exceeding 5 mA.

Magnetic fields can also induce voltages and currents in conducting objects. Typically, this requires a long metallic object, such as a wire fence or above-ground pipeline that is grounded at only one location. A person who closes an electrical loop by grounding the object at a different location will experience a shock similar to that described above for an ungrounded object. Mitigation for this problem is to ensure multiple grounds on fences or pipelines, especially those that are orientated parallel to the transmission line.

The Scott-Kifer 115 kV transmission line has been constructed in conformance with GO-95 and Title 8 CCR 2700 requirements. Operation of the PPP will not change the operating characteristics of the existing Scott-Kifer 115 kV transmission line; therefore hazardous shocks or other effects of induced current and voltages are unlikely to occur as a result of project construction or operation.

6.3.3 Aviation Safety

Federal Aviation Administration (FAA) Regulations, Part 77 establishes standards for determining obstructions in navigable airspace and sets forth requirements for notification of proposed construction. These regulations require FAA notification for any construction over 200 feet in height above ground level. In addition, notification is required if the obstruction is less than specified heights and falls within any restricted airspace in the approaches to airports. For airports with runways longer than 3,200 feet, the restricted space extends 20,000 feet (3.3 nautical miles) from the runway. For airports with runways measuring 3,200 feet or less, the restricted space extends 10,000 feet (1.7 nautical miles). For heliports, the restricted space extends 5,000 feet (0.8 nautical mile).

Although it may be necessary to notify the FAA due to other tall elements of the project, the height and location of the existing on-site transmission tower for the Kifer-San Jose and Newark-Kifer 115 kV transmission line (80 feet) does not trigger a review. This tower will be relocated a few feet to the northwest, and will be more distant from the airport than its present position (see Figure 2.2-2). As a result of their location and height in relation to the San Jose International Airport, the on-site transmission structures will not have an impact to aviation safety as defined in the FAA regulations.

6.3.4 Fire Hazards

The existing Scott-Kifer 115 kV transmission line has been constructed in accordance with GO-95, which establishes clearances from other man-made and natural structures as well as tree-trimming requirements to mitigate fire hazards. Operation of the PPP will not change the operating characteristics or maintenance procedures of the existing Scott-Kifer 115 kV transmission line, therefore no impacts to fire hazards are anticipated.

6.4 APPLICABLE LAWS, ORDINANCES, REGULATIONS, AND STANDARDS

This section provides a list of applicable laws, ordinances, regulations, and standards (LORS) that apply to the proposed transmission line, substations and engineering. The following compilation of LORS is in response to Section (h) of Appendix B attached to Article 6, of Chapter 6, of Title 20 of the California Code of Regulations. Inclusion of these data is further outlined in the CEC's publication entitled "Rules of Practice and Procedure & Power Plant Site Certification Regulations."

6.4.1 Design and Construction

Table 6.4-1 lists the applicable LORS for the design and construction of the proposed transmission interconnection and substations.

Table 6.4-1. Design and construction LORS.

LORS	Applicability
General Order 95 (GO-95), CPUC, "Rules for Overhead Electric Line Construction"	California Public Utility Commission (CPUC) rule covers required clearances, grounding techniques, maintenance, and inspection requirements.
Title 8 California Code of Regulations (CCR), Section 2700 et seq. "High Voltage Electrical Safety Orders"	Establishes essential requirements and minimum standards for installation, operation, and maintenance of electrical installation and equipment to provide practical safety and freedom from danger.
General Order 128 (GO-128), CPUC, "Rules for Construction of Underground Electric Supply and Communications Systems"	Establishes requirements and minimum standards to be used for the station AC power and communications circuits.
General Order 52 (GO-52), CPUC, "Construction and Operation of Power and Communication Lines"	Applies to the design of facilities to provide or mitigate inductive interference.
ANSI/IEEE 693 "IEEE Recommended Practices for Seismic Design of Substations"	Provides recommended design and construction practices.
IEEE 1119 "IEEE Guide for Fence Safety Clearances in Electric-Supply Stations"	Provides recommended clearance practices to protect persons outside the facility from electric shock.

Table 6.4-1. (continued).

LORS	Applicability
IEEE 998 "Direct Lightning Stroke Shielding of Substations"	Provides recommendations to protect electrical system from direct lightning strokes.
IEEE 980 "Containment of Oil Spills for Substations"	Provides recommendations to prevent release of fluids into the environment.
Suggestive Practices for Raptor Protection on Powerlines, April 1996	Provides guidelines to avoid or reduce raptor collision and electrocution.

6.4.2 Electric and Magnetic Fields (EMF)

The applicable LORS pertaining to electric and magnetic field interference are tabulated in Table 6.4-2.

Table 6.4-2. Electric and magnetic field LORS.

LORS	Applicability
Decision 93-11-013 of the CPUC	CPUC position on EMF reduction.
General Order 131-D (GO-131), CPUC, Rules for Planning and Construction of Electric Generation, Line, and Substation Facilities in California	CPUC construction-application requirements, including requirements related to EMF reduction.
Pacific Gas & Electric Company, "Transmission Line EMF Design Guidelines"	Large local electric utility's guidelines for EMF reduction through structure design, conductor configuration, circuit phasing, and load balancing. (In keeping with CPUC D.93-11-013 and GO-131)
ANSI/IEEE 644-1994 "Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines"	Standard procedure for measuring EMF from an electric line that is in service.

6.4.3 Hazardous Shock

Table 6.4-3 lists the LORS regarding hazardous shock protection for the project.

Table 6.4-3. Hazardous shock LORS.

LORS	Applicability
Title 8 CCR Section 2700 et seq. "High Voltage Electrical Safety Orders"	Establishes essential requirements and minimum standards for installation, operation, and maintenance of electrical equipment to provide practical safety and freedom from danger.
ANSI/IEEE 80 "IEEE Guide for Safety in AC Substation Grounding"	Presents guidelines for assuring safety through proper grounding of AC outdoor substations.
National Electrical Safety Code (NESC), ANSI C2, Section 9, Article 92, Paragraph E; Article 93, Paragraph C.	Covers grounding methods for electrical supply and communications facilities.

6.4.4 Communications Interference

The applicable LORS pertaining to communication interference are presented in Table 6.4-4.

Table 6.4-4. Communications interference LORS.

LORS	Applicability
Title 47 CFR Section 15.25, “Operating Requirements, Incidental Radiation”	Prohibits operations of any device emitting incidental radiation that causes interference to communications. The regulation also requires mitigation for any device that causes interference.
General Order 52 (GO-52), CPUC	Covers all aspects of the construction, operation, and maintenance of power and communication lines and specifically applies to the prevention or mitigation of inductive interference.
CEC staff, Radio Interference and Television Interference (RI-TVI) Criteria (Kern River Cogeneration) Project 82-AFC-2, Final Decision, Compliance Plan 13-7	Prescribes the CEC’s RI-TVI mitigation requirements, developed and adopted by the CEC in past siting cases.

6.4.5 Aviation Safety

Table 6.4-5 lists the aviation safety LORS that may apply to the proposed construction and operation of the PPP.

Table 6.4-5. Aviation safety LORS.

LORS	Applicability
Title 14 CFR Part 77 “Objects Affecting Navigable Airspace”	Describes the criteria used to determine whether a “Notice of Proposed Construction or Alteration” (NPCA, FAA Form 7460-1) is required for potential obstruction hazards.
FAA Advisory Circular No. 70/7460-1G, “Obstruction Marking and Lighting”	Describes the FAA standards for marking and lighting of obstructions as identified by Federal Aviation Regulations Part 77.
Public Utilities Code (PUC), Sections 21656-21660	Discusses the permit requirements for construction of possible obstructions in the vicinity of aircraft landing areas, in navigable airspace, and near the boundary of airports.

6.4.6 Fire Hazards

Table 6.4-6 tabulates the LORS governing fire hazard protection for the PPP project.

Table 6.4-6. Fire hazard LORS.

LORS	Applicability
Title 14 CCR Sections 1250-1258, "Fire Prevention Standards for Electric Utilities"	Provides specific exemptions from electric pole and tower firebreak and electric conductor clearance standards, and specifies when and where standards apply.
ANSI/IEEE 80 "IEEE Guide for Safety in AC Substation Grounding"	Presents guidelines for assuring safety through proper grounding of AC outdoor substations.
General Order 95 (GO-95), CPUC, "Rules for Overhead Electric Line Construction" Section 35	CPUC rule covers all aspects of design, construction, operation, and maintenance of electrical transmission line and fire safety (hazards).

6.4.7 Involved Agencies and Agency Contacts

Table 6.4-7 identifies national, state, and local agencies with jurisdiction to issue permits or approvals, conduct inspections, and/or enforce the above referenced LORS. Table 6.4-7 also identifies the associated responsibilities of these agencies as they relate to the construction and operation of the PPP.

Table 6.4-7. Jurisdiction.

Agency or Jurisdiction	Responsibility
California Energy Commission (CEC)	Jurisdiction over new transmission lines associated with thermal power plants that are 50 megawatts (MW) or more (PRC 25500).
CEC	Jurisdiction of lines out of a thermal power plant to the interconnection point to the utility grid (PRC 25107).
CEC	Jurisdiction over modifications of existing facilities that increase peak operating voltage or peak kilowatt capacity 25 percent (PRC 25123).
CPUC	Regulates construction and operation of overhead transmission lines (General Order No. 95 and 131-D) (those not regulated by the CEC).
CPUC	Regulates construction and operation of power and communications lines for the prevention of inductive interference (General Order No. 52).
Federal Aviation Administration (FAA)	Establishes regulations for marking and lighting of obstructions in navigable airspace (AC No. 70/7460-1G).
Local Electrical Inspector	Jurisdiction over safety inspection of electrical installations that connect to the supply of electricity (NFPA 70).
Cal-ISO	Provides Final Interconnection Approval.
City of Santa Clara	Establishes and enforces zoning regulations for specific land uses. Issues variances in accordance with zoning ordinances. Issues and enforces certain ordinances and regulations concerning fire prevention and electrical inspection.

6.5 REFERENCES

Electric Power Research Institute. 1978. 115-138-kV compact line design. In: *Transmission line reference book*. Palo Alto, California.

IEEE Power Engineering Society. 1985. Corona and field effects of AC overhead transmission lines, information for decision makers. July, 1985. New York, NY.

Pacific Gas & Electric (PG&E). 1998. *PG&E Interconnection Handbook.*